Report for 2001MO3041B: Spatial Distribution, Geochemistry, and Sources of Phosphorus and Metals in Bottom Sediments in the James River Arm of Table Rock Lake

There are no reported publications resulting from this project.

Report Follows:

Preliminary Final Report-January 27, 2003

Spatial Distribution, Geochemistry, and Sources of Phosphorus and Metals in Bottom Sediments in the James River Arm of Table Rock Lake

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Progress Overview

All work on the project has been completed according to plan. Results of the study have been presented at two meetings: (1) White River Basin Forum, Springfield, MO, November 2001, and (2) 9th Annual Symposium on the Interactions between Sediment and Water, Banff, Canada May 2002, . The final report will take the form of a MS thesis in Resource Planning from SMSU and is currently in the final stages of preparation.

Objective 1: Watershed and Bathymetric Mapping

GIS layers for bathymetry, elevation, land use, dock locations, and geology were developed from various federal and state sources including the USGS, USACE, and MDNR. The location and elevation of the flooded James River channel and valley floor features classified from the GIS data based were augmented with GPS and depth measurements collected during sampling. The contributing drainage area and land use above tributary or cove samples was also determined for analysis of nonpoint source influence on phosphorus concentrations.

Objective 2: Bottom Sediment Characterization

The study area includes the Table Rock lake area along the 48 km length of the James River arm from Galena, Missouri to the White River. Over 200 sediment samples were collected at GPS-located sites in both the main channel of the lake and its tributary coves. Depth was determined using a hull-mounted "fish-finder" device and checked with a hand-held sonar. All sediment samples were analyzed for particle size, organic matter content, and bulk geochemistry including concentrated HCl-HNO3 extractable phosphorus, urban metals (Cu, Hg, Pb, Zn), and substrate-forming metals (Al, Fe, Mn, and Ca).

Objective 3: Assessment of Biochemical Mobility

Nine bottom sediment samples were selected for sequential extraction procedures to determine the form of the phosphorus in the sediment. Five different P fractions were evaluated: (1) exchangeable; (2) carbonate; (3) Al/Fe hydroxides; (4) apatite; and (5) Organic or residual.

Preliminary analysis indicates that the P distribution of the sediment varies only slightly among the sites studied. The most biochemically mobile fractions (exchangeable and carbonate-bound) tend to contain between 40 and 55 % of the sediment-P in the lake and cove samples. About 20 to 30 % is found in the organic or residual fraction. There are no obvious spatial trends (downstream or depth) in the fractionation data. Generally, about half of the phosphorus in the bottom sediments of the James River arm may potentially be biologically available, depending on redox and sedimentation conditions.

Objective 4: Spatial Variability

While water-column data generally show the decay of total-P (ug/l) downstream from the James River mouth near Galena, bottom sediment P (ug/g) concentrations increase downlake suggesting that sedimentation is the major process controlling P transport to the main lake. Sediment-P concentrations are relatively variable and range from 300 to 850 ug/l along the 10 km long river-lake transition area. Over the next 38 km, P concentrations gradually increase with depth from 1,000 to 2,400 ug/g. Depending on the statistical sampling procedures and assumptions selected, sediment-P concentrations in the main stem of the arm are predictable based on depth or distance from Galena, organic matter or clay content of the sample, and concentrations of Al, Ca, Fe, and Mn in the sediment.

Relatively high concentrations of sediment-P were found in the shallow, upstream reach of the arm below McCord's Bend where algal blooms and fish kills occurred during the summer months in the past. Patterns of phosphorous distribution in the James River arm generally differed from those of metals typically released from nonpoint sources. However, urban metal levels tended to be low throughout the lake with the exception of a few high samples of Hg in the upper arm reaches and Cu near the confluence of Aunt's Creek in the lower reaches of the arm. Several samples collected from the White River portion of Table Rock Lake indicate that enriched levels of bottom sediment-P are extending out into the main lake from the James River arm.

Efforts to explain variations in tributary or cove sediment-P concentrations with land use variables including percent urban, agricultural, and forested area, dock and road density, and tributary lake and watershed area were not successful. This was due to two main factors. First, phosphorus enrichment of bottom sediments by anthropogenic sources probably occurs at levels far below the influence of natural sediment sorption processes and background source variations. Second, land use variables covaried with cove watershed size in a manner that countered source-P tranport linkages in the regression analyses. For example, while larger watershed areas had more urban development due to historical settlement trends, lower slopes, and building site availability, they also were more forested and had greater potential for dilution from background sediment transport. Also, the main plume of phosphorus moving down lake was able to enter and become deposited within very small coves with low discharges; large coves had enough runoff to counter this effect or were large enough to evade detection during this study.

The results of this study suggest that phosphorus contamination problems in the main arm are mainly the result of fluvial inputs from the James River at Galena and not sources located in its direct cove drainages. However, this study did not evaluate the local effects of phosphorus

introductions from nonpoint sources in the coves on sediment-P levels. Also, this study did not resolve the effect of P treatment upgrades on Springfield's Southwest Treatment Plant, which has been the primary source of P to the arm in the past.

Objective 5: Phosphorus Budget

Published data on water-column total phosphorus concentrations in the James River arm and James River at Galena and mean annual discharge at gaging sites in southwest Missouri is used to develop a phosphorus budget for the James River arm of Table Rock Lake. This transport budget is compared with sediment-P storage to understand the role of sedimentation and sediment remobilization in the James River arm. Under average hydrologic conditions, preliminary results indicate that most of the phosphorus entering the lake at Galena and from other nonpoint sources via tributary cover inputs is removed by sedimentation or biologic uptake before reaching the main lake on the White River. The budget model indicates a slight net release to the main lake that supports previous findings of elevated bottom sediments in Table Rock Lake just downstream of the James River arm confluence. The importance of bottom sediment storage and cycling to P transport in the James River arm has not yet been investigated, but will be included in the final report in Marc Owen's master's thesis.